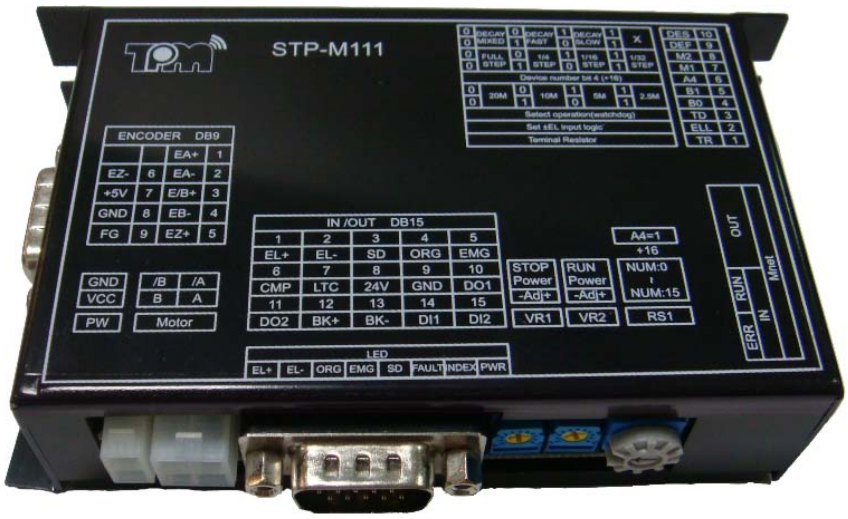
Stepper Driver

STP-M111 User Manual

Version: V1.2 2012J30

To properly use the product, read this manual thoroughly is necessary.



Part No.: 81-00STP10-010

Revision History

Date	Revision	Description
2012/9/3	1.0	Document creation.
2013/1/1	1.1	Added an illustration on system architecture.
2013/1/28	1.2	1. Update mechanical dimensions. 2. Added options of STP-M111A and STP-M111B

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Electrical safely

- To prevent electrical shock hazard, disconnect the power cable from the electrical outlet before relocating the system.
- When adding or removing devices to or from the system, ensure that the power cables for the devices are unplugged before the signal cables are connected. Disconnect all power cables from the existing system before you add a device.
- Before connecting or removing signal cables from motherboard, ensure that all power cables are unplugged.
- Seek professional assistance before using an adapter or extension card. These devices could interrupt the grounding circuit.
- Make sure that your power supply is set to the voltage available in your area.
- If the power supply is broken, contact a qualified service technician or your retailer.

Operational safely

- Please carefully read all the manuals that came with the package, before installing the new device.
- Before use ensure all cables are correctly connected and the power cables are not damaged. If you detect and damage, contact the dealer immediately.
- To avoid short circuits, keep paper clips, screws, and staples away from connectors, slots, sockets and circuitry.
- Avoid dust, humidity, and temperature extremes. Do not place the product in any area where it may become wet.
- If you encounter technical problems with the product, contact a qualified service technician or the dealer.

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1. Introduction

STP-M111 is a 2-phase high speed Motionnet interfaced stepping motor driver. Encoder support and high precision position drive simplifies the control of motion.

1.1. Precautions

1.1.1. Safety precautions

When you operate a stepper motor, you must take the utmost care to keep people from entering the zone in which components are being moved by the motor. In addition, provide an emergency stop mechanism to stop the motor operation instantly if a person is in danger.

1.1.2. Handling precautions

- Inputting power
  Do not connect or disconnect connectors and signal lines while this board or peripheral circuits are supplied with power.

- Static electricity
  This board uses a CMOS device. Therefore this board must be stored in a package in which it was shipped until you actually use it, in order to prevent damage from static electricity.

- Switch settings
  This board is equipped with switches to set details for serial communications and input/outputs. Be sure to shut off the power supply to the board before changing these switches.

- Connections to electrically noisy devices
  Interference from excessively noisy devices or from power surges on the power and I/O circuits may cause the board to malfunction. To connect to a device, which may generate electrical noise, we recommend taking countermeasures, such as attaching a protective circuit to the input/output circuits. However, it is best not to share the same power supply with noise generating sources.

1.2. Features

STP-M111 has two types by encoder feedback.
STP-M111A – with encoder (counter) support
STP-M111B – without encoder (counter) support

1.2.1. Serial Communications

- Data transfer speed
  Maximum is 20 Mbps. Default speed is 10Mbps.

- Cyclic communication time and transfer cycle
  Cyclic communication time
  Maximum 15.1 μs/ unit (Data transfer speed: 20 Mbps)
  Cyclic data transfer cycle
  Maximum 0.97 ms / when connected to 64 local devices (Data transfer speed 20 Mbps)
  (As the number of devices connected grows smaller, the transfer speed gets proportionally faster.)

- Data communication time
  Max. 19.3 μs
  (When writing a 4-byte feed amount instruction to the feed amount register in the G9103A)

- Number of devices that can be connected
  Maximum 32 devices / line

- Connection method
  Multi-drop connections using LAN cables

- Serial communication types
  Three types of communication are available.
  1) System communication
  By polling the Motionnet line, the number of local devices that are connected, the device numbers, device types, and I/O port allocation status can all be checked.
  2) Cyclic communication
  The system starts communication with the local device that has the lowest device number. When the communication cycle reaches the device with the highest device number, the system starts over again, communicating with the device that has the lowest device number. The process of communicating with all active devices, from the lowest to the highest device, is one cycle. The system repeats this

communication cycle endlessly.

The primary status conditions (such as the pulse output status) and general input/output data control of the G9103A is handled using cyclic communications.

3) Data communication

This type of communication is used to read and write data between a PCL device and a CPU emulation device. Data is written into a FIFO buffer in the central device, and then a send command is issued. These communications are sent and received automatically, during the interrupt driven cyclic communications. Data communications are used to send operation commands and register data to a G9103A.

- Communication error detection

  Errors can be detected by adding CRC numbers to the serial communication frames.

1.2.2. Motion control

- Interrupt signal output

  This driver can send a variety of interrupt requests to the central board using cyclic communications.

- Acceleration/deceleration control

  Both linear and S-curve acceleration/deceleration is available. The S-curve acceleration/deceleration also allows use of linear acceleration/deceleration parts.

- Speed override

  The speed can be changed during any operation in all the modes.

- Overriding the target position

  The target position (feed amount) can be changed during positioning using the positioning mode function. When a feed operation has already passed the new target position, the motor will decelerate and stop (stop immediately when performing a constant speed operation), and start to feed in the opposite direction.

- A variety of counter circuits (STP-M111A only)

  The following three counters are available.

Counter	Use	Count input
COUNTER1	28-bit counter for controlling the specified position	Output pulse
COUNTER2	28-bit counter for controlling the mechanical set position	Output pulse, EA/EB input
COUNTER3	16-bit counter for controlling differences between the specified position and the actual machine position. Or,	Output pulse, EA/EB input

	16-bit general-purpose counter with a synchronous signal output function.	Outputs pulses at 1/4096 of the reference clock, EA/EB input

You can reset any of the counters with a command.
And, you latch the counter data with a command or by supplying an ORG signal.

- Comparator (STP-M111A only)
  The driver has three comparator circuits, which allow it to compare between preset values and internal counter values.
  Select from COUNTER 1 (specified position counter), COUNTER 2 (mechanical position counter), or COUNTER 3 (general-purpose and difference counter) to make comparisons.
  In addition, comparator 1 and 2 can also be used as software limit counters (+SL, -SL).

- Software limit function
  You can set software limits using the comparator 2 circuit.
  When the motor operation enters the software limit range, the motor immediately stops or decelerates and stops. Then, it can only be driven in the reverse direction.

- Backlash correction
  The driver has a backlash correction function.
  The backlash correction function corrects feed amount each time the feed direction changes.

- Synchronization signal output function
  The driver can output pulse signals at a specified rate for a specified interval.

- Vibration restriction function
  Preset a control constant and this function adds 2 pulses each to both forward and reverse rotations that occur just before stopping the motor.
  This function reduces the mechanical shock that can occur on the motor axis when it is stopped.

- Operation mode
  The basic operations using this driver are continuous operation, positioning, and zero return operation.
  The driver supports various operations by setting optional operation mode bits.
  <Examples of the operation modes>
  1) Continuous mode using commands
  2) Zero returning operations
  3) Positioning operations using a command.
  4) Interpolation mode using a command.

- A variety of zero return sequences
  STP-M111 supports 13 homing modes which listed in the “Motionnet Programming Manual”.

- Mechanical system input signals
  The following four signals can be input.
  1) PEL (+EL)
     If this signal goes on while the motor is in turning in the positive direction, it will stop immediately. Or, if preset environment conditions are met, it will decelerate and stop.
     The motor cannot be rotated in the positive direction while this signal is on (it can rotate only in the negative direction).
  2) MEL (-EL)
     If this signal goes on while the motor is turning in the negative direction, it will stop immediately. Or, if preset environment conditions are met, it will decelerate and stop.
     The motor cannot be rotated in the negative direction while this signal is on (it can rotate only in the positive direction).
  3) SD
     This signal can be used as a deceleration signal or as decelerate and stop signal, depending on the settings in the program.
     When SD is set to be used as a deceleration signal, and if this signal goes active while in high-speed operation, the motor will decelerate to FL speed.
     Also, if this signal is already active when starting the motor, the motor will operate at FL constant speed.
     When this signal is set to be used as a decelerate-and-stop signal, and if this signal goes active while in high-speed operation, the motor will decelerate to FL speed and then stop.
  4) ORG
     This is an input signal used for zero return operations.

  For safety, arrange your system so that PEL (+EL) and MEL (-EL) signals remain on from the EL position all the way to the end of the stroke. You can also change the logic of these signals using a switch. The logic of the SD and ORG signals can be changed using a program.

- EMG – Emergency stop signal input
  When this signal goes active, the affected axis stops rotating immediately. No axis can be operated as long as this signal is active.

- EA, EB and EZ
  These terminals are to control the current position using an encoder. 90 degree phase difference signals or

Two-pulse (UP pulse and DOWN pulse) can be input on these terminals. The 90 degree phase difference signals can be multiplied by 2 or by 4. The EZ input is used for origin return operations. Software can be used to change the input logic of these terminals. These terminals have built-in pull up resistors to prevent floating. When these terminals are not used, they can be left open. If you want to improve noise resistance of the chip, pull them up (5 to 10 K-ohms) or connect them to the VDD.

- LTC
  This terminal is to latch the specified counter (COUNTER 1 to 3) by inputting a signal. (It can latch more than one counter). Software can be used to change the input logic of this terminal. This terminal has a built-in pull up resistor to prevent floating. When this terminal is not used, it can be left open. However, if you want to improve noise resistance, pull it up (5 to 10 K-ohms) to the VDD or connect it to the VDD.

- CMP
  The signal output when the comparator condition is satisfied.

- Position checking
  STP-M111 is a stepping motor driver to control motors with encoder mounted by checking the final position of the target position. It also provides functional applications for users to get the current position of the encoder value.

1.2.3. Motor driver

- Required power
  This board requires 24 VDC±10%

- A motor that can be controlled
  2-phase stepper motor, maximum 2.0 A/phase

- Driving method
  Uni-polar and bipolar

- Micro step
  Select from 4 steps (division by 1, 4, 16, and 32)

- Excitation ON/OFF control
  The motor excitation can be switched on and off using a general-purpose output from the G9103A.

1.3. Specifications

The functions offered by this board can be classified as serial communications, motion control, and motor driving operations.

1.3.1. Serial communications

Item	Signal name	Specifications
Cyclic communication times and data transfer cycles		Communication time: 15.1 μs, maximum. Data transfer cycle Maximum of 0.49 msec, when using 32 devices. #1 Maximum of 0.97 msec, when using 64 devices. #2 (Data transfer speed: 20 Mbps, when using our recommended cable #1:100m, #2: 50m)
Date communication time		Maximum 19.3 μs (When writing a 4 byte feed amount into the feed register in the G9103A)
Total serial communication line length		Maximum of 100 m (At a data transfer speed of 20 Mbps with 32 devices connected) Maximum of 50 m (At a data transfer speed of 20 Mbps with 64 devices connected) Maximum of 100 m (At a data transfer speed of 10 Mbps with 64 devices connected) (Using our recommended cables)
Serial communication method		Half-duplex communication
Connection method		Multi-drop connection using a LAN cable or our proprietary cable.
Serial communication device number	RS1 and A4	Assignable device numbers, 0 to 32 The rotary switch can set the device id ranging from 0 to 15. For device ranging from 16 to 32, the A4 switch needs to be switched to 1.
Serial communication transfer speed	SW1 – B0, B1	20 Mbps/10 Mbps/5 Mbps/2.5 Mbps Set using switches.
Transmission resistance	SW2-TR	Select whether to use a termination resistor on the last the serial communication station. Set using a switch
Display serial communication	RUN, ERR	RUN: While receiving serial communications normally,

Item	Signal name	Specifications
status		the green LED is lit. ERR: When a serial communication error occurs continuously, the red LED is lit.

1.3.2. Motion Control

Item	Signal name	Specifications
Positioning control range		-134,217,728 to 134,217,727 (28 bits)
Ramp down point setting range		0 to 16,777,215 (24 bits)
Number of speed setting registers		3 types: FL, FH, and FA (correction speed)
Speed setting step range		1 to 100,000 (17 bits)
Magnification rate for setting the speed range		Magnification rate: 0.1 to 66.6x When the magnification rate is 0.1, the speed setting range is 0.1 to 10,000.0 pps When the magnification rate is 1, the speed setting range is 1 to 100,000 pps When the magnification rate is 50, the speed setting range is 50 to 5,000,000 pps Note: The maximum speed of the driver is 250 Kpps. The speed can be limited by the specifications of the motor used.
Acceleration / deceleration characteristics		Acceleration and deceleration can be set independently for linear acceleration/deceleration, and also for S-curve acceleration/deceleration.
Acceleration setting range		1 to 16,383 (14 bits)
Deceleration setting range		1 to 16,383 (14 bits)
Automatically set ramp down point		It is possible to set the ramp down point automatically within the range of (deceleration time) < (acceleration time x 2)
FH correction function (escaping triangle drive)		When the feed amount is small and the motor may possible to start deceleration on the way of acceleration (triangle drive), this function automatically lowers the operation speed and escape this triangle drive.

Counter		COUNTER 1: Specified position counter (28 bits) COUNTER 2: Mechanical position counter (28 bits) COUNTER 3: Difference counter (16 bits)
Comparators		3 at 28 bits each
Mechanical signal inputs	PEL, MEL, SD, ORG, and EMG	- Positive end limit input (PEL) - Negative end limit input (MEL) - Ramp down input (SD) - Zero position input (ORG) - Emergency stop input (EMG) [I/F] Photo coupler input
Display input status	L4 to L8	The respective LED lights when a mechanical input is active and the respective photo coupler goes on.
Setting the end limit input logic	SW1-EL L	End limit input logic switch Set using a switch.
Break signal	BK+, BK-	Break signal output.

1.3.3. Motor Driving Operations

Item	Signal name	Specifications
Driving method		2-phase, uni-polar and bipolar
Operation speed		250 Kpps (at maximum)
Motor current setting	VR2	2.0 A/phase (maximum) set using a variable resister. (Set to 1.2 A per phase when delivered)
Reduced current level	VR1	Set using a variable resistor (Set to 50% of the normal current level when delivered)
Auto current reduction		Chose whether to reduce the current automatically after the motor operation ends. Can be disabled by using a G9103A general-purpose output.
Motor excitation on/off		Motor excitation control can be turned on/off Can be controlled using a G9103A general-purpose output.
Phase excitation zero point		The phase excitation zero point can be monitored using the Z-phase input on the G9103A.

1.3.4. Others

Item	Signal name	Specifications
Power requirements		24 VDC±10% - Consumption current, maximum 0.04 A (at no load) - Consumption current, approximately 1.1 A (when a 2.0 A/phase motor is connected) (The current consumption varies, depending on the specification of the motor coils, the operation speed, etc.)
Cooling method		Natural cooling
Operating temperature range		0 to +40˚C
Operating ambient humidity		80%RH or less (Non condensing through the +10˚C to +40˚C range)
Measures for environmental problem		Complies with the EU RoHS requirement

2. Hardware Specifications

2.1. Mechanical Dimensions

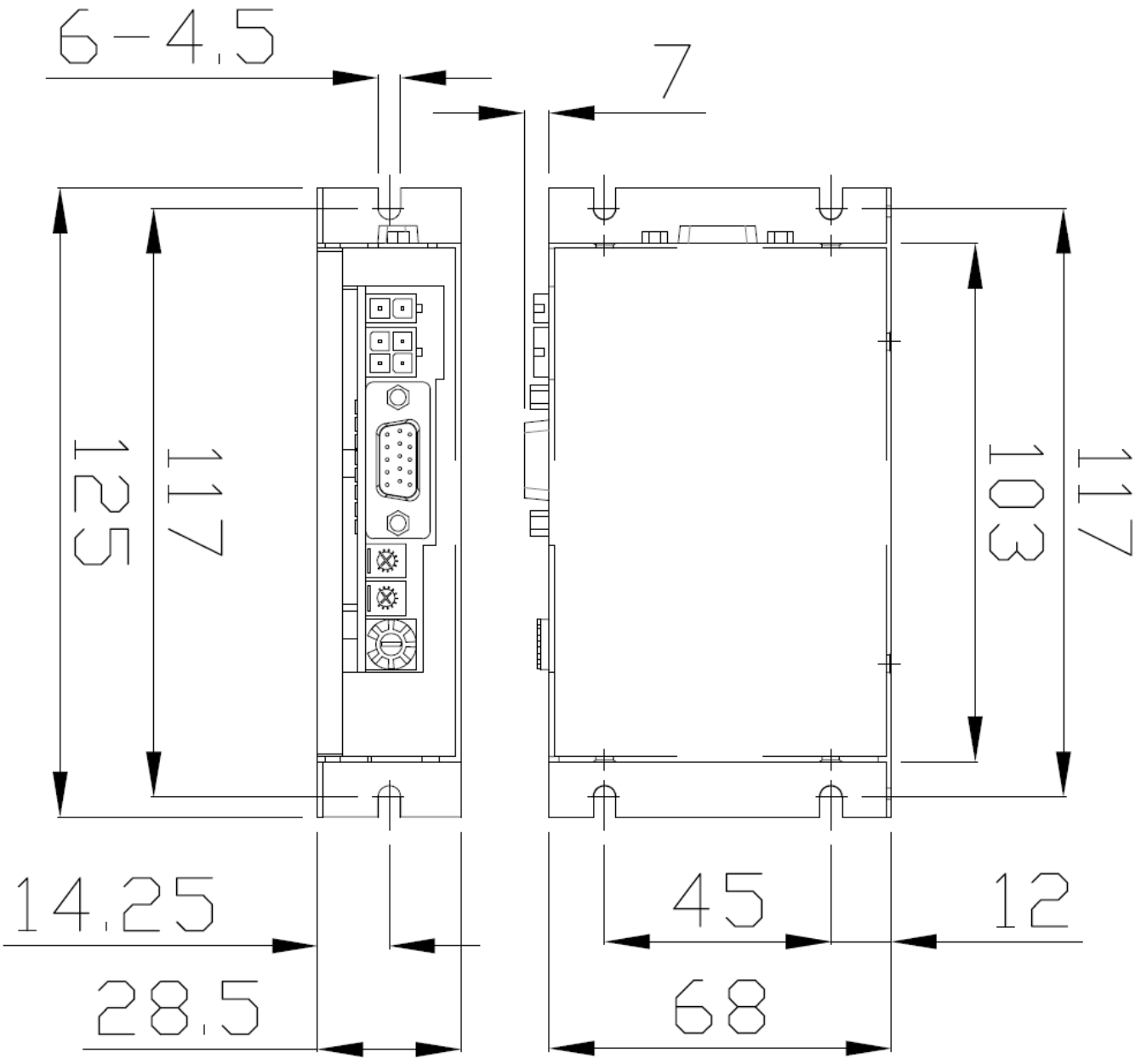


Figure 2-1: mechanical dimensions of STP-M111

2.2. I/O Interfaces

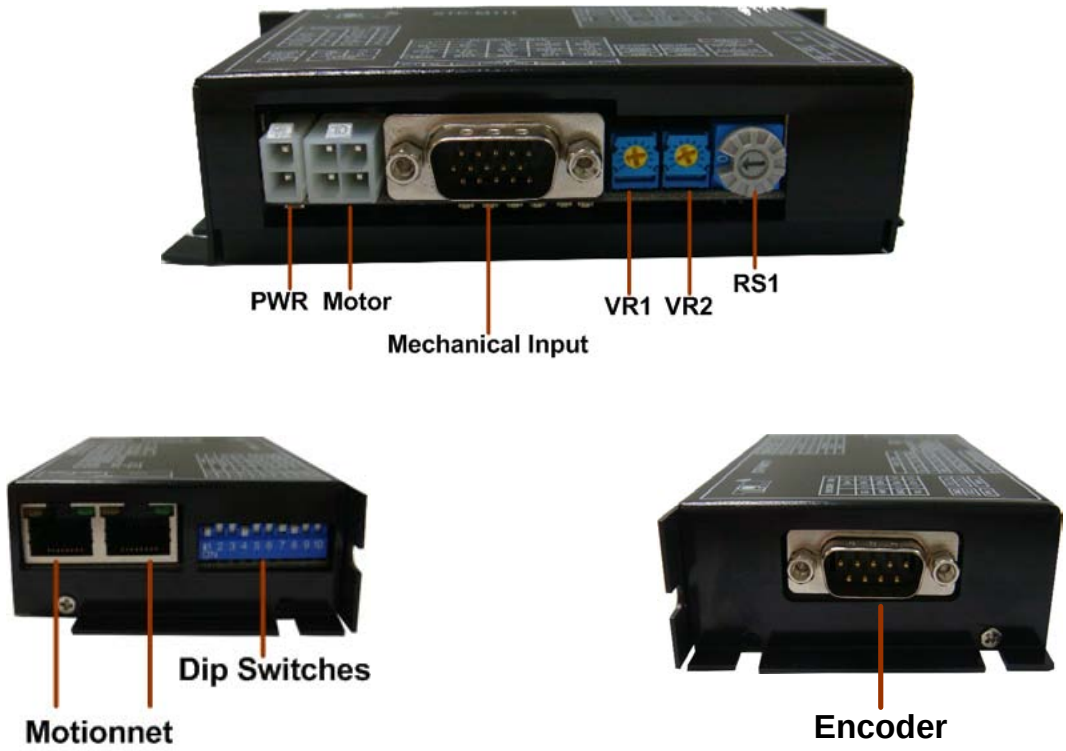


Figure 2-2: connectors of STP-M111

2.2.1. Dip Switches

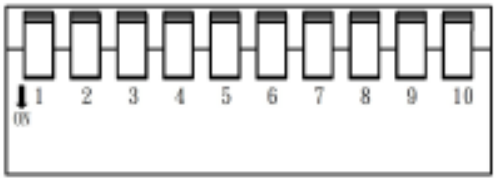


Figure 2-3: system configuration by dip switches

<table>
<tr><th>Number</th><th>Name</th><th>Description</th></tr>
<tr><td>1</td><td>TR</td><td>Setting of the terminal resistance. The default settings are all off.
<table>
<tr><th>TR</th><th>Logic</th></tr>
<tr><td>OFF</td><td>No terminal resistance added.</td></tr>
<tr><td>ON</td><td>Added a terminal resistance.</td></tr>
</table></td></tr>
<tr><td>2</td><td>ELL</td><td>Setting the logic of positive and negative limits. Default values are all off.
<table>
<tr><th>EL</th><th>Logic</th></tr>
<tr><td>OFF</td><td>When the optical coupling light is on, limit signal is on.</td></tr>
<tr><td>ON</td><td>When the optical coupling light is on, limit signal is off.</td></tr>
</table></td></tr>
<tr><td>3</td><td>TD</td><td>Watchdog option
<table>
<tr><th>TD</th><th>Logic</th></tr>
<tr><td>OFF</td><td>The LSI keeps its current status.</td></tr>
<tr><td>ON</td><td>The LSI resets I/O port output and immediately stops pulse output (stop operation).</td></tr>
</table></td></tr>
<tr><td>4, 5</td><td>B0, B1</td><td>Setting of transfer rate. Default values are all off.
<table>
<tr><th>B0</th><th>B1</th><th>Transfer rate</th></tr>
<tr><td>OFF</td><td>OFF</td><td>20Mbps</td></tr>
<tr><td>ON</td><td>OFF</td><td>10Mbps</td></tr>
<tr><td>OFF</td><td>ON</td><td>5Mbps</td></tr>
<tr><td>ON</td><td>ON</td><td>2.5Mbps</td></tr>
</table></td></tr>
<tr><td>6</td><td>A4</td><td>Device number bit 4 (+16)</td></tr>
<tr><td>7, 8</td><td>M1, M2</td><td>Microstep mode
<table>
<tr><th>M1</th><th>M2</th><th>Microstep mode</th></tr>
<tr><td>OFF</td><td>OFF</td><td>Full step</td></tr>
<tr><td>ON</td><td>OFF</td><td>1/4 step</td></tr>
<tr><td>OFF</td><td>ON</td><td>1/16 step</td></tr>
<tr><td>ON</td><td>ON</td><td>1/32 step</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Number</th><th>Name</th><th>Description</th></tr>
<tr><td>9, 10</td><td>DEF, DES</td><td>Decay mode
<table>
<tr><th>DEF</th><th>DES</th><th>Decay mode</th></tr>
<tr><td>OFF</td><td>OFF</td><td>Decay mixed</td></tr>
<tr><td>ON</td><td>OFF</td><td>Decay fast</td></tr>
<tr><td>OFF</td><td>ON</td><td>Decay slow</td></tr>
<tr><td>ON</td><td>ON</td><td>Reserved</td></tr>
</table></td></tr>
</table>

2.2.2. Motionnet Rings

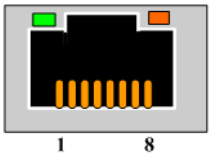
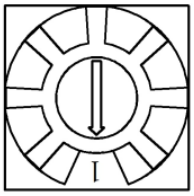


Figure 2-4: Motionnet extension connector Ring

Pin	Pin Mark	Pin Description
1	NC	Reserved
2	NC	Reserved
3	RS485+	Motionnet protocol +
4	NC	Reserved
5	NC	Reserved
6	RS485-	Motionnet protocol -
7	NC	Reserved
8	NC	Reserved

Table 2-1: pin definition of the Motionnet Ring

2.2.3. RS1 – Rotary Switch



Main function of the rotary switch is to indicate the ID of the module raging from 0 to 15. For module ID larger than 15, the 6th switch of the dip switch, A4, needs to be switched to 1.

2.2.4. VR1 – Stop Power

2.0 A/phase (maximum) set using a variable resister.
(Set to 1.2 A per phase when delivered)

2.2.5. VR2 – Run Power

Set using a variable resistor.
(Set to 50% of the normal current level when delivered)

2.2.6. Mechanical Input

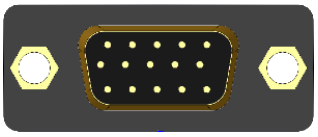
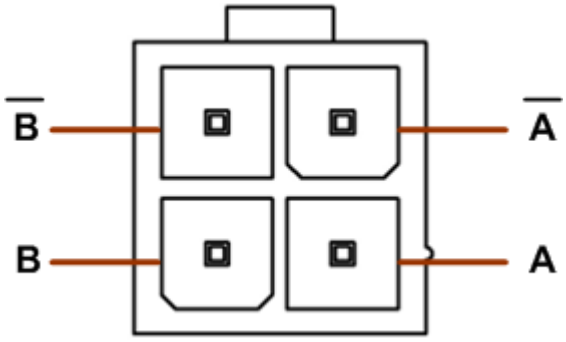


Figure 2-5: mechanical input DB15 connector

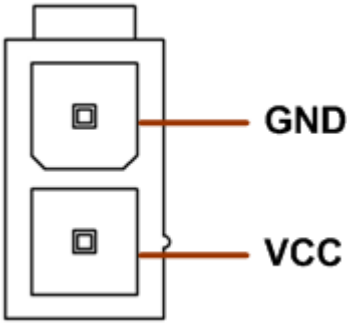
Pin	Name	Function	I/O	Pin	Name	Function	I/O
1	PEL	Positive limit	I	2	MEL	Negative limit	I
3	SD	Slowdown input	I/O	4	ORG	Home position	I
5	EMG	Emergency stop input	I	6	CMP	Comparator output	O
7	LTC	Latch input	I	8	24V	24V DC input	I
9	GND	Ground	I	10	DO1	Digital output 1	O
11	DO2	Digital output 2	O	12	BK+	Break signal +	O
13	BK-	Break signal +	O	14	DI1	Digital input 1	I
15	DI2	Digital input 2	I	-	-	-	-

Note that the EMG signal needs to be inactive to drive the motor. Otherwise the driver will be in the emergent stop state.

2.2.7. Motor Connector



2.2.8. Power Input



2.2.9. Encoder Source

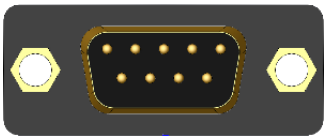


Figure 2-6: encoder source DB9 connector

Pin	Name	Function	I/O	Pin	Name	Function	I/O
1	EA+	Encoder phase A input (+)	I	2	EA-	Encoder phase A input (-)	I
3	EB+	Encoder phase B input (+)	I	4	EB-	Encoder phase B input (-)	I
5	EZ+	Encoder phase Z input (+)	I	6	EZ-	Encoder phase Z input (-)	I
7	+5V	+5V DC input	I	8	GND	Ground	O
9	FG	Frame ground	-				

2.3. Wiring Diagram

The STP-M111 not only controls the stepper motors, but also supports encoder feedback signals. The wiring definition is illustrated in the following figure.

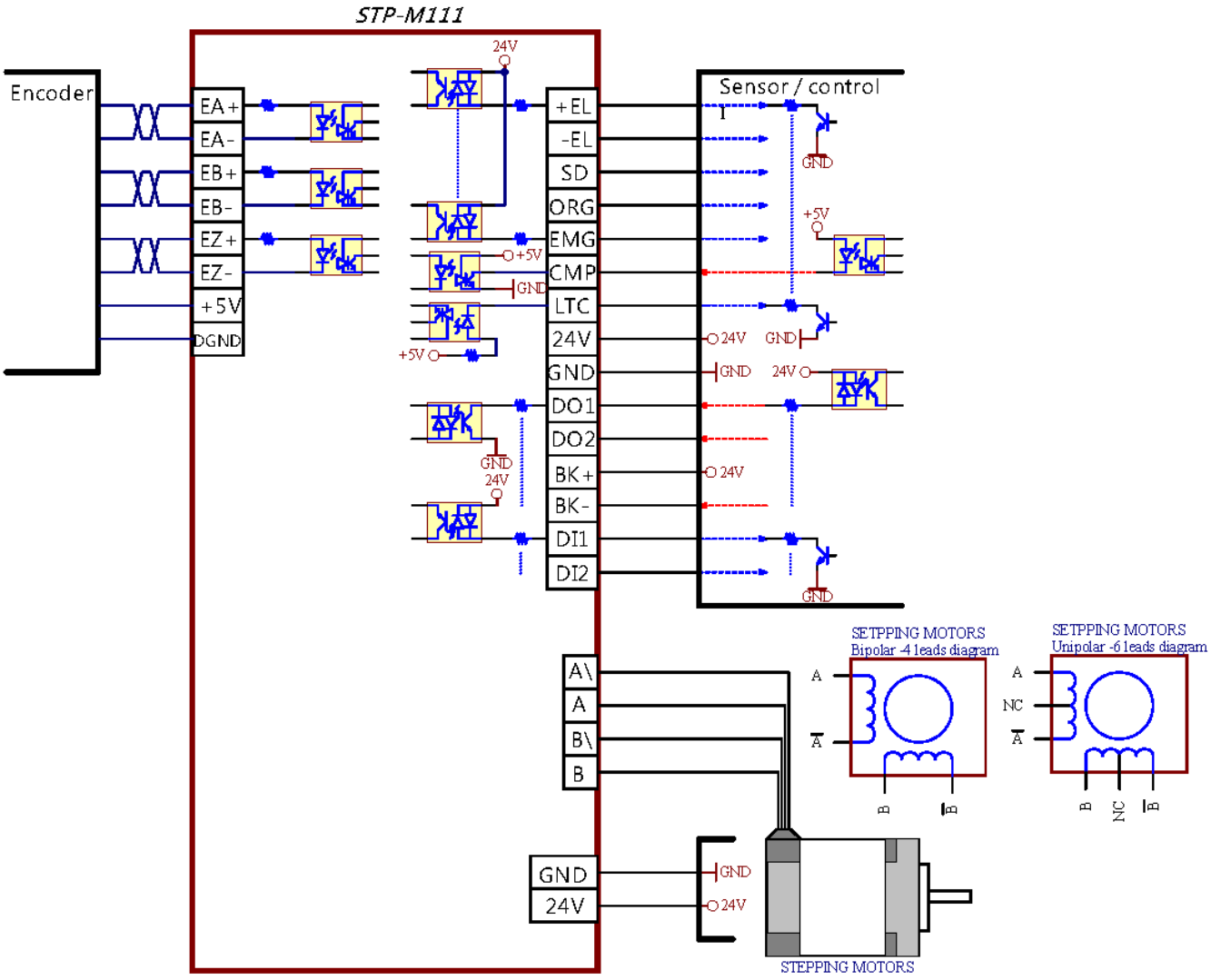
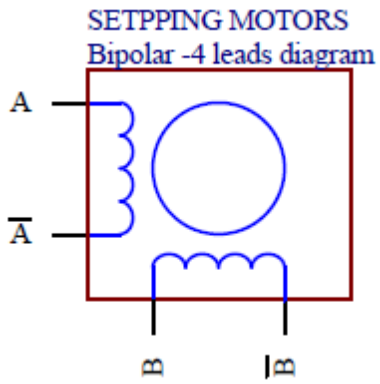
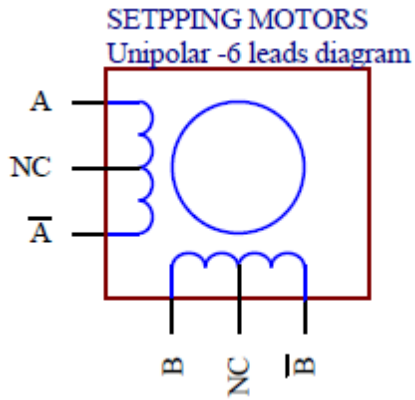


Figure 2-7: wiring configuration illustration

- Bipolar wiring illustration



- Unipolar wiring illustration



2.4. Application Architecture

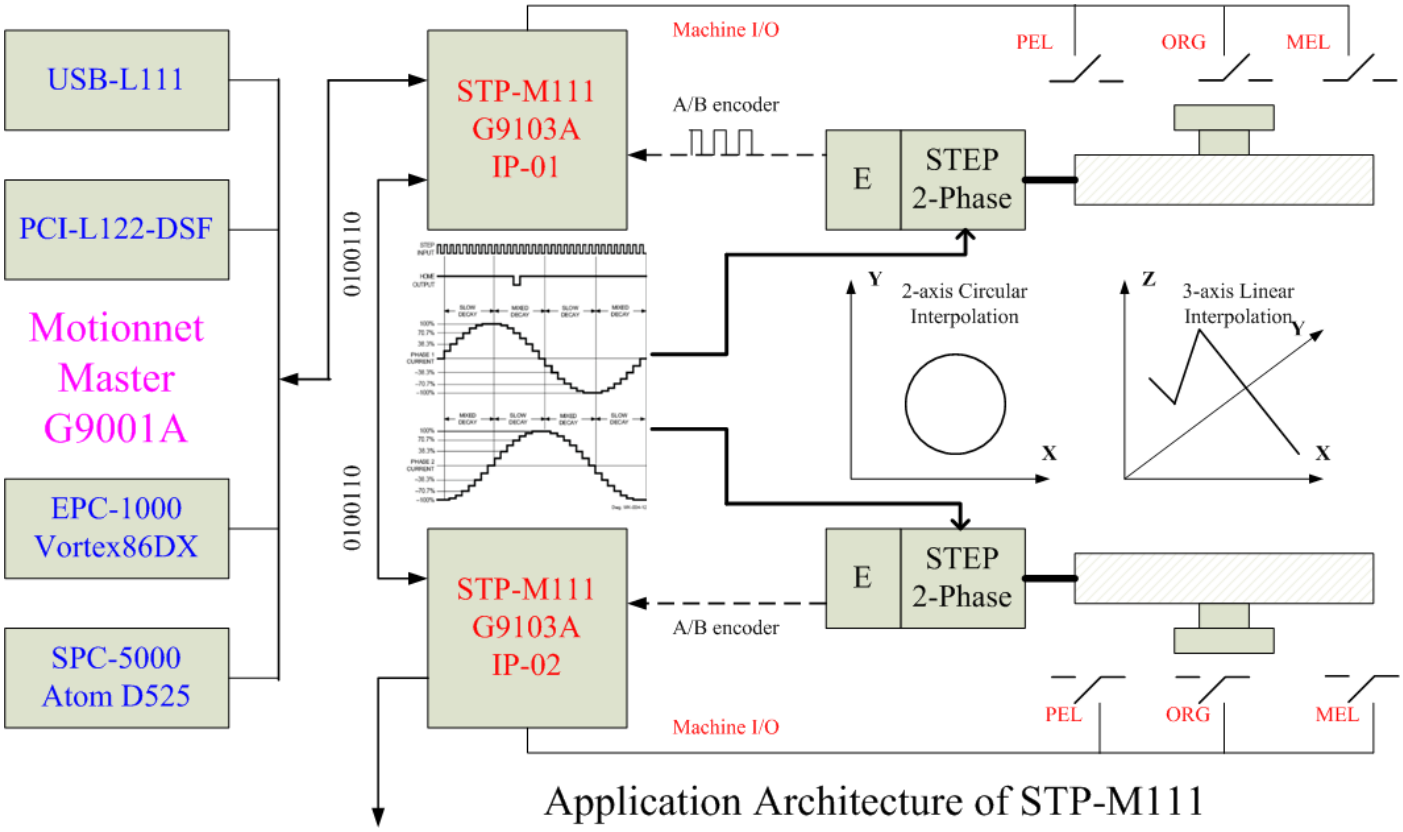


Figure 2-8: application architecture